Reduced Unburned Carbon by Improved Pulverized Coal Burner Balance

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More stringent emission limits or the addition of post combustion NOx control create the need for improvements of NOx emissions from pulverized coal boilers. Low NOx combustion is likely to increase the unburned carbon in the fly ash which results in lower boiler efficiency and restrictions on ash sales. In addition, any imbalance of the air and/or coal supply to the burners has negative effects both on NOx emissions and unburned carbon levels.

Almost every pulverized coal boiler experiences some of the problems associated with poor air and fuel distribution:

- Poor emission performance
- Increased unburned carbon in the fly ash
- Distorted oxygen profile at boiler outlet
- Flame impingement
- Increased slagging
- Water wall wastage

Any deviation from the design flow values at individual burners result in some burners operating at a fuel lean or a fuel rich condition. The fuel rich burner is producing large amounts of CO, high LOI and longer flames while locally lowering the oxygen level in the flue gas. On the other hand, the fuel lean burner produces high NOx levels at elevated O_2. The outcome at the boiler exit is a flue gas with high CO and high NOx. In addition, LOI is elevated due to the burners operating at low stoichiometries. By monitoring and controlling the air and coal flow to the burners, existing as well as new systems greatly benefit from lower emissions and lower unburned carbon.

Balancing across all burners has the following benefits:

- Meet NOx emission with sufficient margin
- Lower LOI
- Lower slagging

- Margin to lower excess air

While measurement and control of air to the burners is existing technology, the measurement and control of the pulverized coal flow is new. During the past years, several technologies emerged to measure the coal flow to individual burners.

Foster Wheeler has partnered with TR-Tech International Oy of Finland to market the Electric Charge Transfer technology (ECT) worldwide. The patented technology measures the electric charges present in any two phase flow transport and uses the signals to determine the relative coal distribution between the conduits of one mill. The absolute flow in each conduit can be readily calculated from the total coal flow to the mill.

The ECT system consists of three receiving antennas in each coal conduit that are connected to a signal conditioning unit. This signal conditioning unit is in turn connected to a personal computer that is used for data processing and analysis. TR-Tech's proprietary software is used to determine the balance between the conduits of one mill, to display the results to the operator and to feed the data to an optional connection to the plant's DCS system for continuos optimization.

The antennas are easily installed through the wall of the existing conduit. Three antennas in one conduit are connected together. Their location in the pipe wall was determined so that the effects of coal ropes on the measurement results are minimized. Antennas are made of hardened steel to ensure long operating life. The installation is very simple and requires only a mill taken out of service for several hours which minimizes lost generating capacity. After installation, the ECT measurement is verified by a standard ASME or other conventional sampling procedures and the system is then ready to be used.

The ECT system offers several distinct advantages:

- On-line and continuous information about the relative distribution of the fuel between the conduits.
- Monitoring of particle size changes and coal layout in conduits possible.
- ECT is not effected by coal type, moisture, ash content or coal roping.
- The signal condition unit can be as far as 1200 feet from the conduits.
- The abrasion resistant antennas in the coal conduit are passive, no power supply is necessary for them.
- The method is very cost effective, since mostly standard equipment is used.
- The installation is easy and can be done during short mill outages.

Field tests of the ECT technology show excellent agreement with standard coal flow measurement methods. ECT is part of Foster Wheeler's approach to NOx emission reduction and unburned carbon improvements for existing low NOx firing systems. Options for the control of the coal flow into individual burner conduits are orificing for the primary air and adjustable riffle boxes or distribution dampers in the fuel distribution system. The choices here greatly depends on the design of the pulverizer and the conduits.